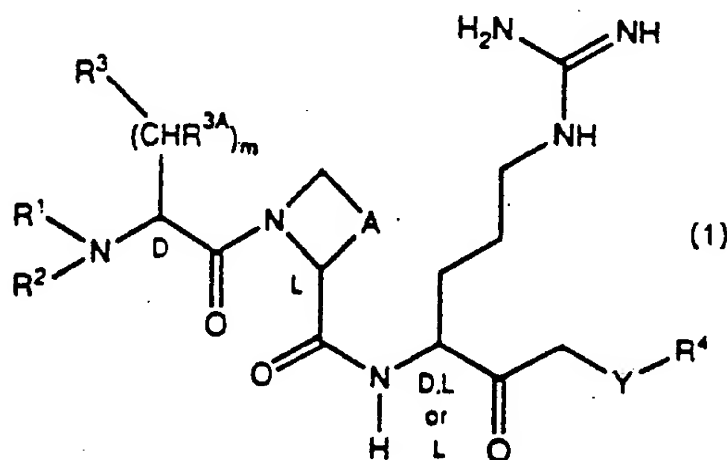




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(54) Title: NEW ISOSTERIC PEPTIDES



(57) Abstract

The invention relates to new competitive inhibitors of thrombin, their synthesis, pharmaceutical compositions containing the compounds as active ingredients, and the use of the compounds as anticoagulants for prophylaxis and treatment of thromboembolic diseases, according to formula (1), wherein A represents $-\text{CH}_2-$, $-\text{CH}=\text{CH}-$, $-\text{CH}_2-\text{CH}_2-$ or $-\text{CH}_2-\text{CH}_2-\text{CH}_2-$; Y represents O or $\text{S}(\text{O})_p$, where p is 0, 1 or 2; R^1 , R^2 , R^3 , R^{3A} , R^4 and m are defined as in the claims, either as such or in the form of a physiologically acceptable salt and including stereoisomers.

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New isosteric peptidesDESCRIPTION

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This invention relates to new competitive inhibitors of thrombin, their synthesis, pharmaceutical compositions containing the compounds as active ingredients, and the use of the compounds as anticoagulants for prophylaxis and treatment of thromboembolic diseases such as venous thrombosis, pulmonary embolism, arterial thrombosis, in particular myocardial infarction and cerebral thrombosis, general hypercoagulable states and local hypercoagulable states, e.g. following angioplasty and coronary bypass operations.

10
15BACKGROUND

Blood coagulation is the key process involved in both haemostasis (i.e. prevention of blood loss from a damaged vessel) and thrombosis (i.e. the pathological occlusion of a blood vessel by a blood clot). Coagulation is the result of a complex series of enzymatic reactions outlined in the Scheme 1 below where the various clotting factors are designated by Roman numerals.

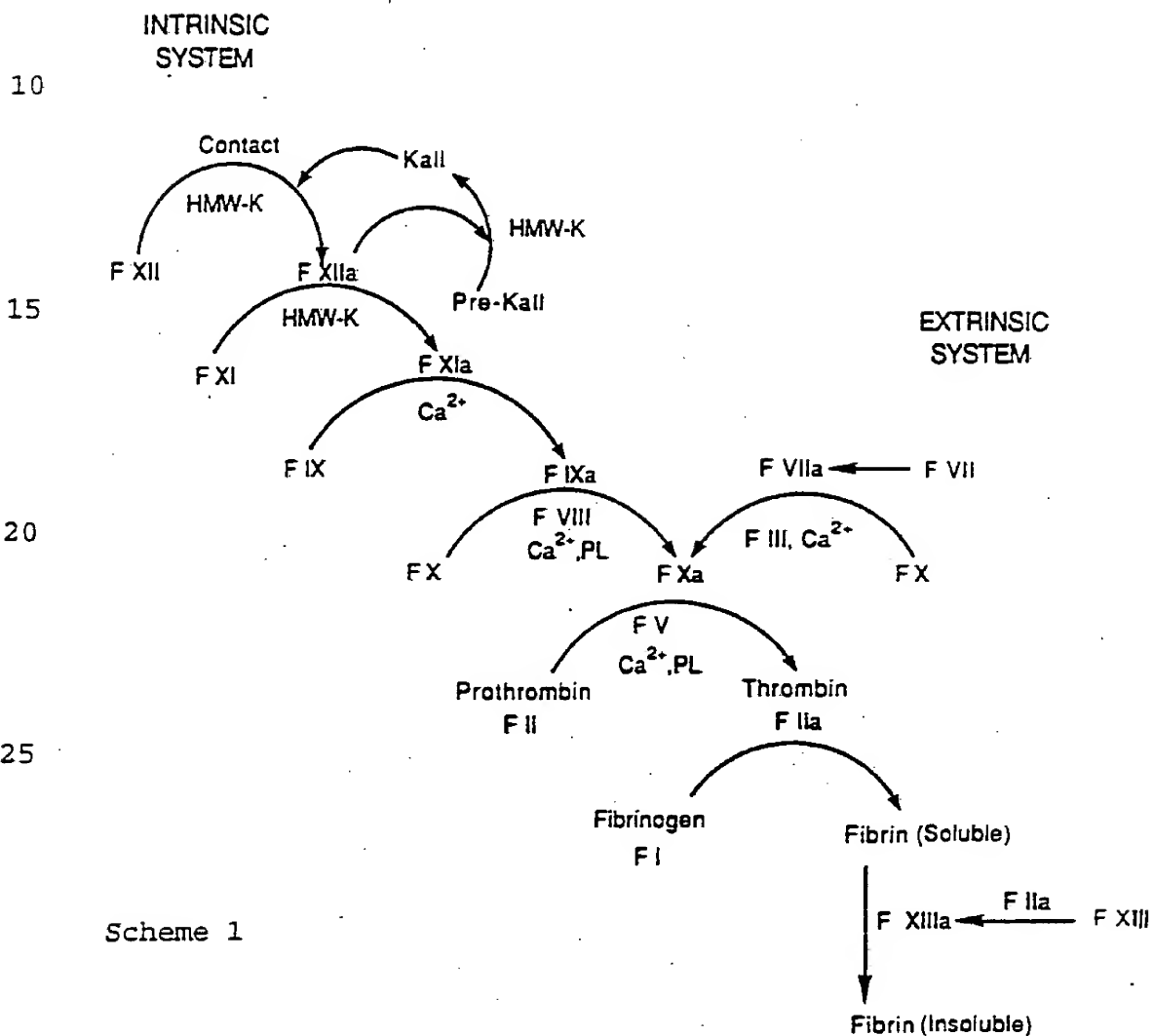
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Thrombin plays a central role in coagulation, whether the process is initiated by the intrinsic or extrinsic pathways: it activates platelets, it converts fibrinogen into fibrin monomers, which polymerise spontaneously into filaments, and it activates FXIII, which in turn crosslinks the polymer to insoluble fibrin. Thrombin further activates FV and FVIII in a positive feedback reaction.

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Inhibitors of thrombin are therefore expected to be effective anticoagulants.

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PRIOR ART

The first inhibitors of thrombin based on electrophilic ketones were developed as described by M. Szelke and D.M. Jones in EP-A1-0,118,280, GB priority date 4th March 1983. These earlier compounds were derived from the $P_3 - P_2'$ pentapeptide sequence of the fibrinogen $A\alpha$ chain in which the scissile $P_1 - P_1'$ peptide bond was replaced with the $-CO-CH_2-$ moiety, forming a keto isostere to the corresponding peptides.

Other known examples of serine proteinase inhibitors based on electrophilic ketones include the following:

- (a) M. Kolb et al. (Merrel-Dow) EP-A2-0,195,212 (Priority date 4.2.86) describing peptidic α -keto esters and amides,
- (b) B. Imperiali and R.H. Abeles, Biochemistry 1986. 25. 3760 (peptidyl fluoroalkyl ketones),
- (c) Ueda et al., Biochem. J. 1990. 265. 539 (peptidyl fluoroalkyl ketones).
- (d) D. Schirlin et al. (Merrel-Dow) EP-A1-0,362,002 (priority date 1.9.88) describing fluoroalkylamide ketones.
- (e) P. Bey et al. (Merrel-Dow) EP-A2-0,364,344 (priority date 7.10.88) describing α, β, δ -triketo compounds.
- (f) E.N. Shaw et al. (Research Corporation) US-4,318,904 (priority date 25.04.80) describing peptide chloro-methyl ketones e.g. H-DPhe-Pro-Arg- CH_2Cl

Inhibitors of thrombin based on peptide aldehydes have been reported by S. Bajusz et al. in J. Med. Chem. 1990. 33. 1729, and in (Richter Gedeon Vegyeszeti Gyar R T) EP-A2-0,185,390 (priority date 21.12.84). Thrombin

inhibitors as peptides comprising C-terminal boronic acid derivatives of arginine and isothiuronium analogues thereof have been reported by A.D. Kettner et al. (Du Pont) EP-A2-0,293,881 (priority dates 5.6.87 and 6.4.88).

There are examples of thrombin inhibitory arginine derivatives or analogues not containing an electrophilic ketone, e.g.:

10 (a) S. Okamoto et al. (Mitsubishi Chemical Industries Ltd.) EP-A1-0,008,746 (priority date 31.08.78) describing arylsulphonyl arginine amides e.g. argatroban.

15 (b) J. Stürzebecher et al., Pharmazie 1981. 36. 639 (arylsulphonyl p-amidinophenylalanine amides).

An object of the present invention is to provide novel and potent thrombin inhibitors with competitive inhibitory activity towards their enzyme i.e. causing reversible inhibition. A further object is to obtain inhibitors which are orally bioavailable and selective in inhibiting thrombin over other serine proteases. Stability, duration of action, and low toxicity at therapeutic dosages are still further objects of the invention.

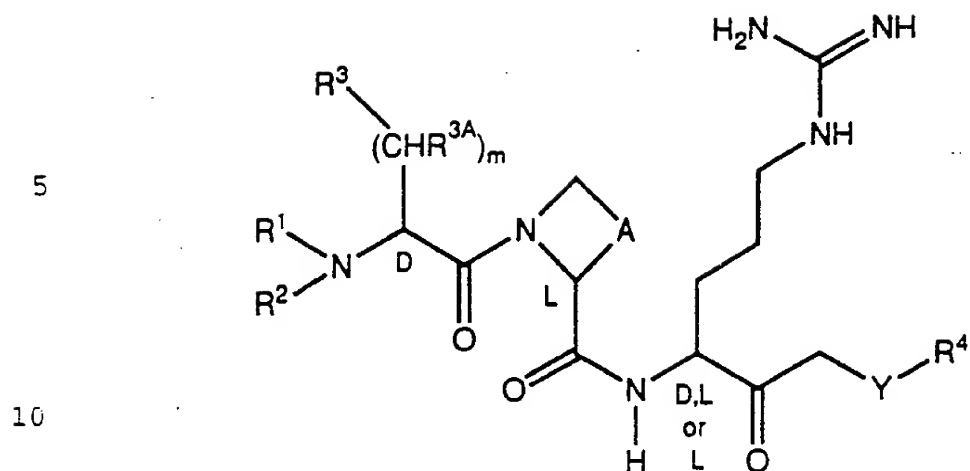
DISCLOSURE OF THE INVENTION

Compounds

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It has been found that compounds of the general formula 1, either as such or in the form of physiologically acceptable salts and including stereoisomers, are potent inhibitors of thrombin:

5



15

In formula 1, and when occurring below unless specified otherwise, the following applies:

20

A represents $-\text{CH}_2-$, $-\text{CH}=\text{CH}-$, $-\text{CH}_2-\text{CH}_2-$ or $-\text{CH}_2-\text{CH}_2-\text{CH}_2-$;

25

R^1 and R^2 are the same or different and each represents H or X-B-, where B is a straight or branched alkylene group having 1-3 carbon atoms and X is H, methyl, ethyl, a cycloalkyl group having 3-6 carbon atoms or $\text{R}'\text{CO}-$, where R' is OH, a straight or branched alkoxy group having 1-4 carbon atoms, NH_2 or NHR'' , where R'' is a straight or branched alkyl group having 1-4 carbon atoms, or X is a carboxylic acid mimic, known per se, selected from $-\text{PO}(\text{OR}''')_2$, $-\text{SO}_3\text{H}$ and 5-(1H)-tetrazolyl, and R''' is H, methyl or ethyl, or B is $-\text{SO}_2-$ and X is methyl or ethyl;

30

m is 0, 1 or 2, R^3 represents a cyclohexyl group and R^{3A} represents H; or

35

m is 1 and R^3 represents a cyclohexyl or phenyl group and R^{3A} forms an ethylene bridge together with R^1 ;

Y represents O or $S(O)_p$, where p is 0, 1 or 2;

5

R^4 represents H; a straight or branched alkyl or a cycloalkyl having 1 to 6 carbon atoms unsubstituted or substituted with one or more fluoro atoms and/or substituted with a phenyl group; a substituted or
10 unsubstituted aromatic ring selected from phenyl, 4-methoxy-phenyl, 4-tertiary-butyl-phenyl, 4-methyl-phenyl, 2-, 3- or 4-trifluoro-methyl-phenyl, phenyl substituted with 1-5 fluoro atoms; or -CH(CF₃)-phenyl.

15

Compounds of formula 1 relate to the peptide sequence of human fibrinogen A α chain representing modified sub-sites P_3 - P_1' :

20

H-Ala-Asp-Ser-Gly-Glu-Gly-Asp-Phe-Leu-Ala-
1 5 10

P_3 P_2 P_1 : P_1' P_2' P_3'
-Glu-Gly-Gly-Gly-Val-Arg—Gly-Pro-Arg-Val-
14 15 16 17 20

25

This sequence is identified as SEQ ID NO: 1 in the Sequence Listing.

30

According to a preferred embodiment the invention relates to compounds of Formula 1, wherein

A represents -CH₂-CH₂- or -CH₂-CH₂-CH₂-;

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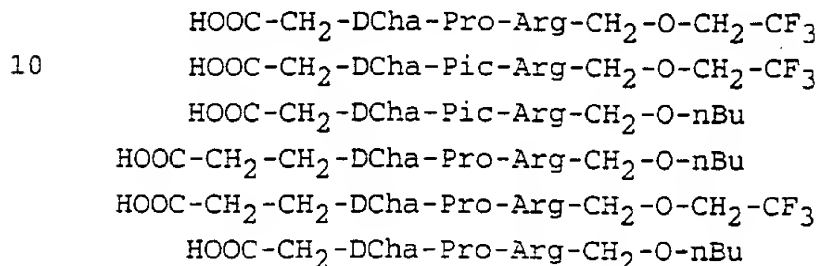
R^1 is H and R^2 represents HOCO(CH₂)_n- or CH₃CH₂OCO(CH₂)_n-, and n is 1 or 2;

Y is O

m is 1, R³ represents a cyclohexyl group and R^{3A} represents H;

5

Particularly advantageous embodiments of the invention are represented by the compounds:



15

Medical and pharmaceutical use

In a further embodiment the invention relates to treatment, in a human or animal organism, of conditions where inhibition of thrombin is required. The compounds of the invention are expected to be useful in particular in animals including man in treatment or prophylaxis of thrombosis and hypercoagulability in blood and tissues. Disease states in which the compounds have a potential utility, in treatment and/or prophylaxis, include venous thrombosis and pulmonary embolism, arterial thrombosis, such as in myocardial infarction, unstable angina, thrombosis-based stroke and peripheral arterial thrombosis. Further, the compounds have expected utility in prophylaxis of atherosclerotic diseases such as coronary arterial disease, cerebral arterial disease and peripheral arterial disease. Further, the compounds are expected to be useful together with thrombolytics in myocardial infarction. Further, the compounds have expected

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utility in prophylaxis for reocclusion after thrombolysis, percutaneous transluminal angioplasty (PTCA) and coronary bypass operations. Further, the compounds have expected utility in prevention of rethrombosis after microsurgery. Further, the compounds are expected to be useful in anticoagulant treatment in connection with artificial organs and cardiac valves. Further, the compounds have expected utility in anticoagulant treatment in haemodialysis and disseminated intravascular coagulation. The daily dosage will normally be within 0.1 mg to 10 g of active ingredient. Intravenous solutions preferably contain 0.1-100 mg/ml, while a dosage unit preferably contains 1-1000 mg and is preferably administered 1-4 times a day.

15

A further expected utility is in rinsing of catheters and mechanical devices used in patients in vivo, and as an anticoagulant for preservation of blood, plasma and other blood products in vitro.

20

Preparation

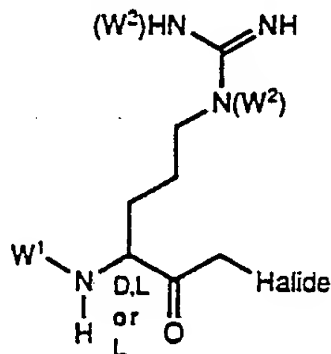
A further objective of the invention is the mode of preparation of the compounds of the invention. Thus the invention further relates to a process for preparation of compounds according to formula 1, which process comprises

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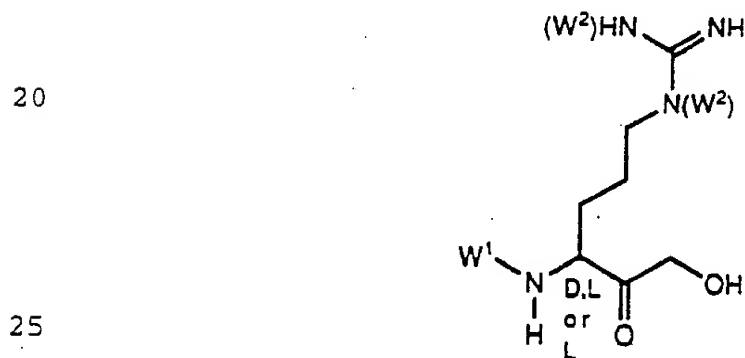
(method I) displacement by R^4Y^- ($Y=O, S$) of the halogen of a halomethylketone of the formula

30

35

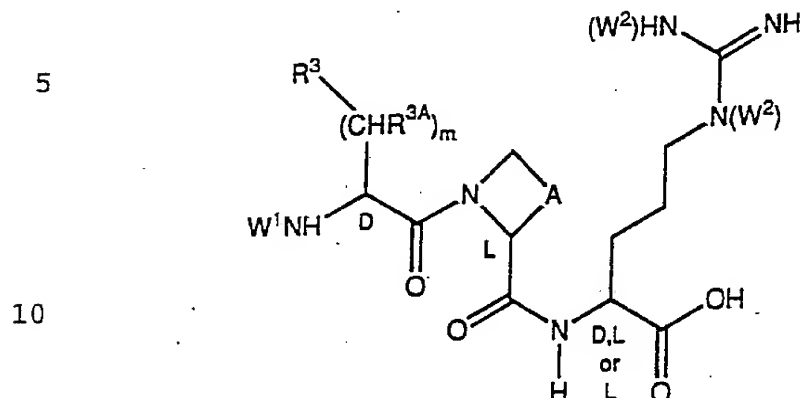


wherein W^1 is an amino terminal protecting group such as tertiary butoxycarbonyl and W^2 is a protecting group such as benzyloxy carbonyl, (as illustrated in Procedures (A), (D) and (F)), reduction of the ketone to alcohol, removal of the amino terminal protecting group, standard peptide coupling, followed by oxidation of the alcohol, giving the protected tripeptide ketone, removal of the amino terminal protecting group, followed by N-alkylation, (as illustrated in Procedures (A), (B), (G) and (H)), and deprotection, or replacing a protected dipeptide in the coupling reaction referred to above and illustrated (eg. Procedure (A)(iii)), with an amino-terminal-N-alkylated-N-trifluoroacetyl-protected dipeptide (Procedure K), followed by oxidation and deprotection, or (method II) alkylation, with an R^4 -halide, of an α -ketol of the formula



wherein W^1 and W^2 are as defined above, (as illustrated in Procedure (E)), and then further reacting as in method I, or (method III) by using the modified Dakin-West reaction, Angew. Chem. Int. Ed. Engl. 8 (1969) 981, as applied to tripeptides, J. Org. Chem., 50 (1985)1112: reacting a compound of the formula (or alternatively to directly use an amino-terminal-N-

alkylated-N-trifluoroacetyl-protected tripeptide)



15 wherein W^1 and W^2 are as defined above, with $(T-CH_2CO)_2O$ wherein T is halogen, R^4O or R^4S and 4-DMAP, and then further reacting as in method I.

20 In those cases where the reaction results in a mixture of stereoisomers, these are optionally separated by standard chromatographic or re-crystallisation techniques, and if desired a single stereoisomer is isolated.

25 DETAILED DESCRIPTION OF THE INVENTION

The following description is illustrative of aspects of the invention.

30 Synthesis and pharmacy

The chemistry used to prepare the inhibitors claimed here is outlined in the Synthesis schemes (Procedures A to H) and Procedures I and K. The necessary alkoxy- or
35 phenoxy-methyl ketones of arginine were mainly prepared

by (I) displacement by R^4O^- of the Br of
bromomethylketones, either using preformed $NaOR^4$
(Procedure A) or by the use of KF (Procedures D and F)
or (II) by alkylation of arginine α -ketol using
5 Ag_2O/R^4I (see Procedure E).

Standard peptide coupling reactions were used to
introduce DCha, Pro and their analogues. The
carboxyalkyl group on the N-terminus was introduced
10 either by alkylation using bromo-acetates or by Michael
addition to tertiary butyl-acrylate (Procedures A, B)
or by using pre-incorporation of carboxy-alkyl in the
dipeptide moiety (see Procedure K). All protecting
groups were then removed (see Deprotection Procedures
15 a-c below).

General experimental procedures:

Standard work-up refers to ethyl acetate extractions,
20 usually washing with 0.3M $KHSO_4$, 1M $KHCO_3$, H_2O and
brine followed by filtration through Whatman Phase
Separatory paper and drying by toluene azeotrope. TLC
was carried out on commercial Merck Silicagel 60F254
coated glass plates. Visualization was by a combination
25 of UV light, heating followed by fluorescamine spray or
heating followed by chlorination (Cl_2 tank) and
spraying with 1% starch/KI solution. Flash
chromatography was carried out on Merck Silicagel 60
(40-63 μm) under pressure of N_2 . Amino acid analysis
30 was performed using the Beckman Gold System. Peptides
were hydrolysed (6N HCl + phenol at 110°C for 22 h)
then injected and the proline peak quantified. MPLC was
carried out in glass columns (Anachem) packed with
Vydac C18 15-25 μm silica, using gradients of 1% TFA-
35 MeCN into 1% TFA- H_2O with monitoring at 226 nm.

Fractions were analyzed by HPLC and the pure ones pooled and lyophilised. HPLC was carried out using a Spectra-Physics 8700 Series chromatography station. Solvent system as for MPLC with detection at 210 nm.

5 Flow 1.5 ml/min. Column: Novapak C18, 4 μ m (8 x 100 mm cartridge, Waters). All intermediates were characterised by NMR (Hitachi-Perkin Elmer R24 60 MHz or Jeol 270 MHz instruments). All final peptides were characterised by their FAB mass spectra (M-Scan Ascot,

10 Berks., U.K.).

Preparation of starting materials:

Boc-Arg(Z₂)-CH₂Br:

15 (i) Boc-Arg(Z₂)-OH (10 mmol) in dry THF (50 ml) and NMM (10 mmol) was cooled to -10°C and iBC (10 mmol) added dropwise keeping the temp. \approx -10°C. After 10 min at -10°C the mixed anhydride was poured into CH₂N₂-ether

20 (25 mmol in 150 ml). After 3h excess CH₂N₂ was destroyed with acetic acid and the solution washed with H₂O (3 x) and brine. Drying and evaporation gave the diazoketone as a yellow oil. IR 2100 cm⁻¹ (COCHN₂).

25 (ii) The diazoketone (10 mmol) in dry ethyl acetate (200 ml) was cooled to -15°C and 1 M HBr/ethyl acetate (about 11 ml) added dropwise. When the yellow colour was discharged TLC (ethyl acetate/hexane) showed complete conversion of the diazoketone to bromomethyl ketone. The solution was rapidly transferred to a

30 separating funnel and washed with 1 M KHCO₃, brine, dried and evaporated to leave a solid. Dissolution in hot EtOH and cooling gave the bromomethyl ketone as an amorphous white powder.

35 NMR (CDCl₃): δ 1.3 (s, 9H), 1.5-1.85 (m, 4H), 3.75-3.95 (m + s, 4H), 4.3 (m, 1H), 5.05 (s, 2H), 5.15 (s, 2H),

5.65 (d, 2H), 7.30 (m, 10H), 9.2 (br, s, 1H), 9.3 (br, s, 1H). Melting point: Softens at 50°C then slowly decomposed >70°C.

5 Boc-DCha-X-ONSu (X = Pro, Pic or Aze):

(i) Boc-DCha-OH (10 mmol) in CH₂Cl₂/DMF (1:5 50 ml) was treated with HONSu (11 mmol), cooled to 0°C and WSCDI (13 mmol) added. After 30 min it was warmed to room temperature. TLC after 3h showed complete formation of Boc-DCha-ONSu. Addition of Et₂O (200 ml) and washing with H₂O (3 x), brine, drying gave the ester as a colourless foam.

(ii) The N-hydroxysuccinimido ester (10 mmol) in CH₂Cl₂ (50 ml) was treated with H-Pro-OBzl.HCl or H-Pic-OBzl.HCl or H-Aze-OBzl (11 mmol) and iPr₂NEt (20 mmol). After stirring for 3h, standard ethyl acetate/0.3 M KHSO₄ work-up gave the dipeptide ester which was pure enough to be used in the next step.

(iii) The Boc-DCha-X-OBzl in THF was hydrogenated over 5% Pd/C at STP for 4h. Filtration and evaporation gave the acid as a solid or foam. Re-crystallisation (iPr₂O or Et₂O/hexane) gave the pure products.
Boc-DCha-Pro-OH (solid m.p. 163 - 166°C): NMR (CDCl₃) δ 0.8-2.05 (m, + s at 1.4, 26H), 3.4 (m, 1H), 3.85 (m, 1H), 4.5 (m, 2H), 5.2 (m, 1H).

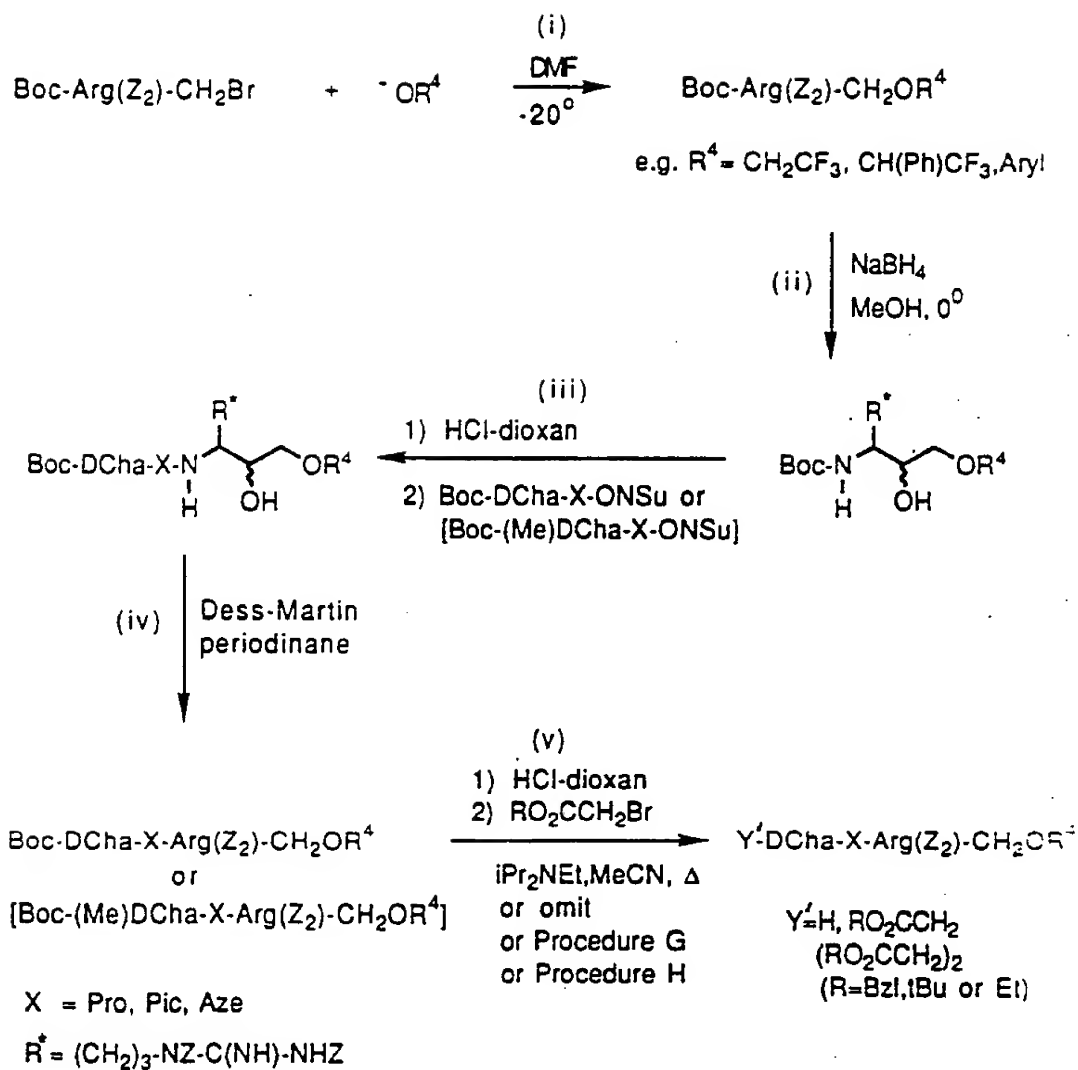
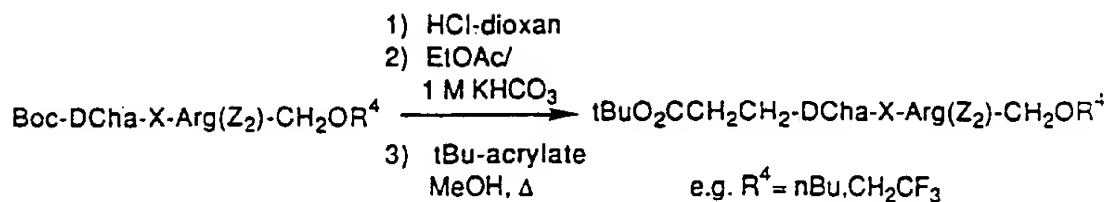
Boc-DCha-Pic-OH (solid m.p. 121-122°C): NMR (CDCl₃) δ 0.8-2.05 (m, + s at 1.45, 28H), 3.35 (m, 1H), 3.95 (m, 1H), 4.6-4.9 (m, 1H), 5.4 (m, 1H), 5.6 (m, 1H), 8.8 (br, s, 1H).

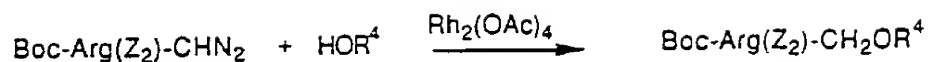
Boc-(Me)DCha-Pro-ONSu:

Boc-(Me)DPhe-OH was hydrogenated over 5% Rh-C in 90% acetic acid-H₂O at 0.41 MPa for 3 days giving
5 quantitative yield of Boc-(Me)DCha-OH. Boc-(Me)DCha-OH (10 mmol) and NMM (10 mmol) in CH₂Cl₂ (50 ml) was cooled to -15°C and Ph₂PO-Cl (10 mmol) added. After 20 min, H-Pro-OBzl.HCl (11 mmol) and NMM (20 mmol) was
10 added. After 1h it was allowed to warm to room temperature. After 2h standard work-up and flash chromatography (40% ethyl acetate/hexane) gave pure Boc-(Me)DCha-Pro-OBzl as a colourless oil (80%).
NMR (CDCl₃): δ 0.5-2.2 (m, + s at 1.4, 26H) 2.65 (s, 3H), 3.5 (m, 2H), 4.3-5.0 (m, 2H), 5.1 (s, 2H), 7.30
15 (s, 5H).

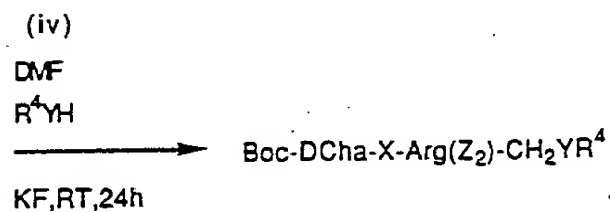
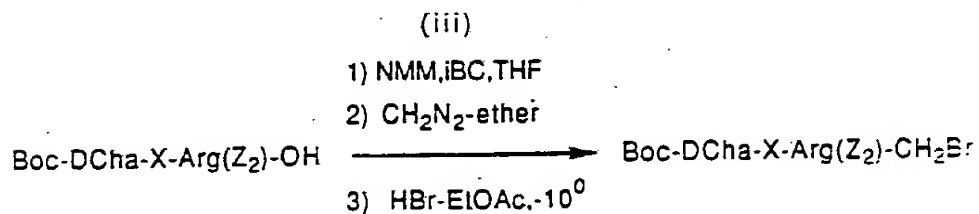
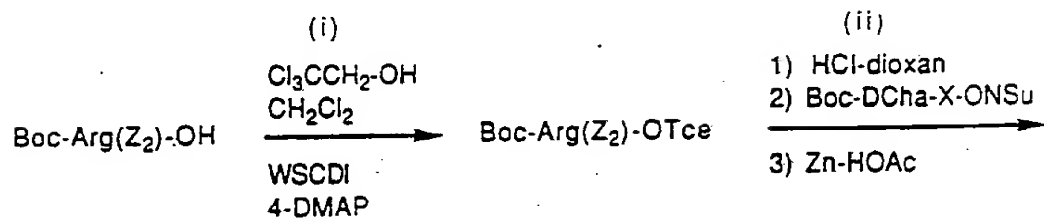
This was converted into the N-hydroxysuccinimido ester as described for Boc-DCha-X-ONSu below.

Synthesis schemes:

Procedure (A)Procedure (B)

Procedure (C)

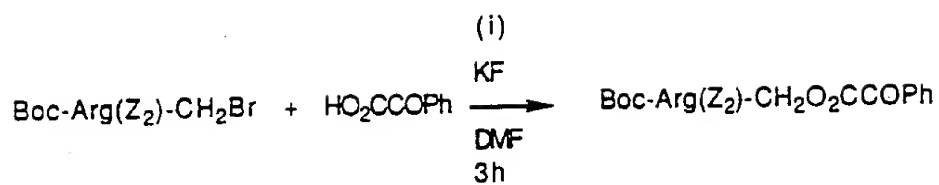
Then continue as in Procedure (A)

e.g. $\text{R}^4 = \text{CH}_2\text{CF}_3, \text{CH(Ph)CF}_3, \text{CH(CF}_3\text{)}_2$ Procedure (D)

Then continue as in Procedure (A)

Y = O, S

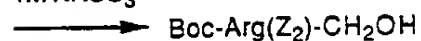
 $\text{R}^4 = \text{nBu, Aryl}$ For Example 1: $\text{R}^4\text{YH} = \text{HO}_2\text{CCOPh}$

Procedure (E)

(ii)

THF
1M KHCO₃

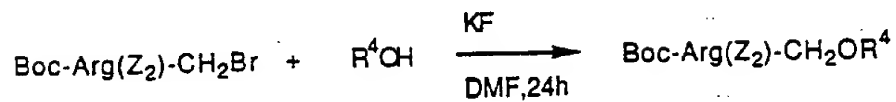
24h



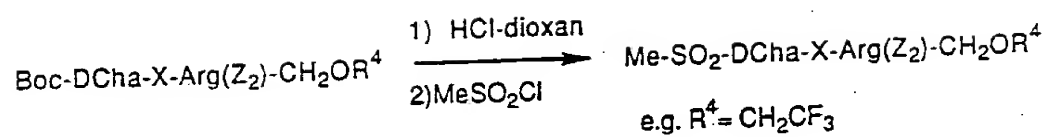
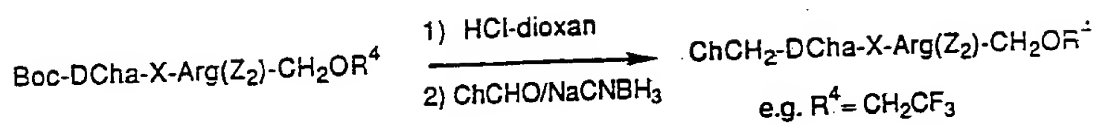
(iii)

Ag₂O
CH₂Cl₂R⁴Ie.g. R⁴=Me, Et, nPr, nBu

Then continue as in Procedure (A)

Procedure (F)e.g. R⁴= CH₂CF₃, CH₂(CF₂)₂CF₃,
Ph(4-OMe)

Then continue as in Procedure (A)

Procedure (G)Procedure (H)

Preparation procedures:

The following preparation procedures illustrate the above methods I-III as well as subsequent steps to final compounds.

Procedure (A)

(i) Boc-Arg(Z₂)-CH₂Br (10 mmol) was added as a solid to a preformed solution of the alkoxide or phenoxide (alcohol or phenol 10 mmol and 80% NaH-oil, 10 mmol) in DMF (40 ml) at -20°C under N₂. After 30 min the solution was warmed to room temperature. 2 hours later 0.3 M KHSO₄ was added to neutralize any alkoxide remaining and the DMF removed under vacuum. The crude product was partitioned between ethyl acetate and H₂O, the ethyl acetate layer washed with brine, dried and evaporated. Flash chromatography or crystallisation gave the pure alkoxyketones.

Boc-Arg(Z₂)-CH₂OPh (solid): NMR (CDCl₃): δ 1.41 (s, 10H), 1.64 - 1.68 (m, 3H), 3.92 (dd, 2H), 4.5 (m, 1H), 4.62 (q, 2H), 5.1 (s, 2H), 5.2 (s, 2H), 5.5 (d, 1H), 6.8 (d, 2H), 6.95 (t, 1H), 7.2-7.45 (m, 12H), 9.2 (br, s, 1H), 9.3 (br, s, 1H). Melting point 115-118°C.

Boc-Arg(Z₂)-CH₂OCH₂CF₃ (solid): NMR (CDCl₃): δ 1.35 (s, 10H), 1.55-1.75 (m, 3H), 3.7 (q, 2H), 3.85 (m, 2H), 4.2 (q + m, 3H), 5.05 (s, 2H), 5.15 (s, 2H), 5.7 (d, 1H), 7.15-7.35 (m, 10H), 9.15 (br, s, 1H), 9.3 (br, s, 1H). Melting point 87-90°C.

(ii) The alkoxymethyl or phenoxymethyl ketone in MeOH/THF (1:1) at 0°C was treated with NaBH₄ (1 equiv.). After 10 min, 0.3 M KHSO₄ was added to pH 7

and the mixture evaporated to remove MeOH/THF. Ethyl acetate was added and after standard work-up (ethyl acetate/0.3 M KHSO₄) the alcohol was isolated as a diastereomeric mixture.

5

(iii) The alcohol was treated with 4M HCl in dioxan for 15 min at room temperature and evaporated. The residue in CH₂Cl₂ (1 mmol in 5 ml) was treated with Boc-DCha-X-ONSu (1 equiv.) and iPr₂NEt (to pH 9 on wet pH paper).

10 After 3h, standard work-up gave the modified tripeptide which was purified by flash chromatography (ethyl acetate-hexane mixtures containing 1% acetic acid). Yield: 50-85%.

15 (iv) The tripeptide alcohol in CH₂Cl₂ was treated with Dess-Martin periodinane (3 equiv.) (Dess, D.B. and Martin, J.C. J. Org. Chem. 1983, 48, 4155-4156). After 2h stirring at room temperature, standard work-up (Et₂O/1 M KHCO₃/Na₂S₂O₃) gave the crude tripeptide
20 ketones which were purified by flash chromatography (ethyl acetate-hexane).

(v) The ketone was treated with 4 M HCl-dioxan for 15 min at room temperature and evaporated. The residue in
25 dry MeCN (1 mmol in 5ml) was treated with benzylbromoacetate or tertiary butyl bromoacetate (1.2 equiv.) and iPr₂NEt (3 equiv.). After reflux for 2h the solution was evaporated and flash columned (ethyl acetate-hexane) giving the benzyloxycarbonylmethyl or
30 tertiary butyloxycarbonylmethyl peptides as oils (40-50%).

In Examples 30 and 31, 2.5 equiv. of the bromoacetate were used to achieve bis-alkylation.

35

Procedure (B)

The peptide alkoxymethylketone was treated with excess 4 M HCl-dioxan for 15 min at room temperature.

- 5 Evaporation gave the HCl salt which was partitioned between ethyl acetate and 1 M KHCO_3 . The ethyl acetate was separated, dried and evaporated giving the free amine which was taken up in MeOH and freshly distilled tertiary butylacrylate added (1.5 equiv.). Reflux for
- 10 4h gave the tertiary butoxycarbonylethyl peptide which was purified by flash chromatography in ethyl acetate/hexane.

Procedure (C)

15

Boc-Arg(Z_2)- CHN_2 (1 mmol) dissolved in the alcohol R^4OH (5 ml) was treated with $\text{Rh}_2(\text{OAc})_4$ (cat.). After several hours at room temperature, TLC analysis showed no diazoketone remaining. The alcohol was removed in vacuo

20 and the product isolated by flash chromatography using ethyl acetate/hexane mixtures.

Procedure (D)

- 25 (i) Boc-Arg(Z_2)-OH (10 mmol) in dry CH_2Cl_2 (50 ml) was treated with 2,2,2-trichloroethanol (11 mmol) and 4-DMAP (1 mmol), cooled to 0°C and WSCDI (13 mmol) added. After 30 min, it was allowed to warm to room temperature and stirred for 24h. Evaporation and
- 30 partition between ethyl acetate/0.3 M KHSO_4 , followed by 3 x washes with 0.3 M KHSO_4 , 1 x H_2O , 1 x brine, drying and evaporation gave the Tce ester which was used as such.
- 35 (ii) The Tce ester (10 mmol) was treated with 4 M HCl-

dioxan (50 ml) for 20 min at room temperature and then evaporated. After drying, the residue in CH_2Cl_2 (50 ml) was treated sequentially with Boc-DCha-X-ONSu (10 mmol) (X = Pro, Pic) and iPr_2NEt (to pH 9 on wet pH paper).

5 After 3h, standard work-up (ethyl acetate/0.3 M KHSO_4) gave the tripeptide ester as an oil. The Tce ester (10 mmol) in 90% acetic acid- H_2O (50 ml) was treated at 5 min intervals with small portions of freshly activated Zn over 1h. After a further 1h, the mixture was
10 filtered and the solution evaporated. Standard work-up (ethyl acetate/0.3 M KHSO_4) gave the tripeptide acid which was purified by flash chromatography on silica (2% acetic acid-ethyl acetate) giving the tripeptide acid as a colourless foam (80% over 3 steps).

15 (iii) The tripeptide acid was converted into the bromomethyl ketone using the same procedure as that described for Boc-Arg(Z_2)- CH_2Br . The tripeptide bromomethyl ketone was obtained as a colourless oil by
20 flash chromatography using ethyl acetate/hexane mixtures.

NMR (CDCl_3): δ 0.9 (m), 1.15 (m), 1.25 (m), 1.35 (s),
1.6 (m), 1.85 (m), 2.1 (m) [total 30H], 3.3 (m, 1H),
25 3.7 (m, 1H), 3.95 (m, 2H), 4.15 (s, 2H), 4.25 (m, 1H),
4.4 (m, 1H), 4.5 (m, 1H), 5.0 (d, 1H), 5.1 (dd, 2H),
5.2 (s, 2H), 7.2-7.4 (s, m, 10H), 9.2-9.5 (2 br, s, 2H).

30 (iv) The tripeptide bromomethyl ketone (1 mmol) in dry DMF (5 ml) was treated with fluorinated alcohol, phenol or thiol (1.2 mmol) and anhydrous potassium fluoride (1.5 mmol) and stirred at room temperature for 24h. Evaporation followed by standard work-up and flash
35 chromatography gave the tripeptide ketones.

Boc-DCha-Pro-Arg(Z₂)-CH₂O-Ph(4-Me): NMR (CDCl₃) δ 0.9 (m), 1.15 (m), 1.25 (m), 1.35 (s), 1.6 (m), 1.85 (m), 2.1 (m) [total 30H], 2.38 (s, 3H), 3.4 (m, 1H), 3.9 (m, 1H), 4.1 (br, s, 2H), 4.4 (m, 1H), 4.6 (m, 1H), 4.7 (m, 1H), 4.9 (q, 2H), 6.9 (d, 1H), 7.15 (d, 1H), 7.4-7.5 (m, 2H), 7.45 (s, 10H), 9.4 (br, s, 1H), 9.6 (br, s, 1H).

For Example 37 the protected sulphide was oxidised to the sulphone using m-chloroperbenzoic acid in dichloromethane at room temperature.

Procedure (E)

(i) Boc-Arg(Z₂)-CH₂Br (10 mmol) and benzoylformic acid (12 mmol) in DMF (40 ml) were treated with KF (14 mmol). After stirring for 3h the DMF was evaporated and the product partitioned between ethyl acetate/H₂O. Drying and evaporation gave the crude benzoylformate ester which was purified by crystallisation (CH₂Cl₂-hexane) giving the product as a white solid (86%).

NMR (CDCl₃): δ 1.4 (s, 9H), 1.65-1.9 (m, 4H), 3.95 (m, 2H), 4.3 (m, 1H), 4.95 (q, 2H), 5.15 (ABq, 2H), 5.25 (s, 2H), 5.9 (d, 1H), 7.35 (m, 10H), 7.5 (t, 2H), 7.65 (t, 1H), 8.15 (t, 2H), 9.25 (br, s, 1H), 9.45 (br, s, 1H). Melting point 130-132°C.

(ii) The benzoylformate ester (5 mmol) in THF (200 ml) and 1 M KHCO₃ (200 ml) was stirred vigorously at room temperature for 24h. The THF was separated and evaporated and the aqueous phase extracted with ethyl acetate which was combined with the material from the THF. Crystallisation from CH₂Cl₂-hexane gave the α-ketol as a white solid (90%).

NMR (CDCl₃): δ 1.4 (s, 9H), 1.7 (m, 4H), 2.95 (t, 1H), 3.95 (m, 2H), 4.25 (m, 2H), 5.15 (s, 2H), 5.25 (s, 2H), 5.6 (d, 1H), 7.35 (m, 10H), 9.25 (br, s, 1H), 9.4 (br, s, 1H). Melting point 101-103°C.

5

(iii) The α -ketol (1 mmol) in dry CH₂Cl₂ (5 ml) was treated with alkyl iodide (5 to 10 mmol) and silver oxide (2 mmol). The mixture was refluxed in the dark for 2 to 17 hours (e.g. MeI, EtI, nPrI: 2h; nBuI: 5h). Evaporation followed by flash chromatography (ethyl acetate-hexane) gave the alkoxyethyl ketones as colourless oils (50-85%).

10

15

Boc-Arg(Z₂)-CH₂OEt (oil): NMR (CDCl₃): δ 1.15 (t, 3H), 1.4 (s, 9H), 1.5-1.8 (m, 4H), 3.4 (q, 2H), 3.95 (t, 2H), 4.1 (q, 2H), 4.45 (m, 1H), 5.15 (s, 2H), 5.25 (s, 2H), 5.4 (d, 1H), 7.35 (m, 10H), 9.25 (br, s, 1H), 9.4 (br, s, 1H).

20

Boc-Arg(Z₂)-CH₂NBu (oil): NMR (CDCl₃): δ 0.9 (t, 3H), 1.25-1.8 (m) + 1.4 (s) [17H], 3.3 (dd, 2H), 3.95 (t, 2H), 4.05 (q, 2H), 4.45 (m, 1H), 5.1 (s, 2H), 5.2 (s, 2H), 5.35 (d, 1H), 7.35 (m, 10H), 9.25 (br, s, 1H), 9.4 (br, s, 1H).

25

Procedure (F)

Boc-Arg(Z₂)-CH₂Br was treated with CF₃CH₂OH, CF₃(CF₂)₂CH₂OH or Ar-OH and KF in DMF using the procedure outlined in Procedure (D) (iv).

30

Procedure (G)

35

The Boc protected peptides were treated with 4 M HCl-dioxan for 15 min at room temperature and evaporated. The residue in CH₂Cl₂ was treated with MeSO₂Cl (1.1 equiv.) and iPr₂NEt (2.5 equiv.). After 1h standard

work-up and flash-chromatography gave the methylsulphonylpeptides which were deprotected as in Deprotection procedure (a).

5 Procedure (H)

The peptides were Boc deprotected as above and the HCl washed out using ethyl acetate/1 M KHCO_3 partition. The free amines in MeOH cooled to 0°C were treated with the
 10 aldehyde Ch-CHO (1.5 equiv.) and NaCNBH_3 (1 equiv.). After 1 hour evaporation in the cold and flash chromatography gave the N-alkylated peptide. Deprotection using Deprotection procedure (a).

15 Procedure (I)

Boc-(3-trans-phenyl)-D,Lproline was prepared as described in Chung et al. J. Org. Chem. 1990, 55, 270, and coupled to H-Pro-OBzl as described above for Boc-
 20 (Me)DCha-Pro-OBzl. The dipeptide was then converted to its -ONSu ester as described below.

Boc-(3-trans-cyclohexyl)-D,Lproline was prepared from the phenyl analogue by hydrogenation over 5% Rh-C in
 25 90% HOAc- H_2O at 0.41 MPa for 3 days.

Procedure (K)

Synthesis of the intermediate N-(BzlO₂C-CH₂-), N-(CF₃CO)-DCha-Pro-ONSu

30 Z-DCha-Pro-OtBu $\xrightarrow[\text{NaCNBH}_3]{\begin{array}{l} \text{(i) H}_2 \text{ -Pd/C} \\ \text{(ii) BzlO}_2\text{C-CHO,} \end{array}}$ N-(BzlO₂C-CH₂-), N-(CF₃CO)-DCha-Pro-ONSu

35 $\xrightarrow[\begin{array}{l} \text{(iv) TFA} \\ \text{(v) HONSu, WSCDI} \end{array}]{\text{(iii) (CF}_3\text{CO)}_2\text{O}}$

(i) Z-DCha-Pro-OtBu (made by standard peptide coupling reactions) was hydrogenated in THF over 5% Pd-C at standard temperature and pressure for 24 h. Filtration and evaporation provided H-DCha-Pro-OtBu (oil, 100%).

5

(ii) The previous product (2 mmol) and benzyl glyoxylate (1 equivalent) in benzene were subjected to three evaporations (fresh benzene added each time) to remove water. The residual imine (2 mmol) in 1% acetic acid/methanol (8 ml) was treated with NaCNBH₃ (2 mmol). After 1 h, evaporation followed by flash chromatography on silica (60% EtOAc-hexane) gave BzlO₂C-CH₂-DCha-Pro-OtBu, 385 mg (41%).

10

(iii) The above product (380 mg) in dry CH₂CL₂ (8 ml) was treated with Et₃N (2 equivalents) and (CF₃CO)₂O (1.2 equivalents). After 40 min, evaporation and flash chromatography (silica, 30% EtOAc-hexane) gave the N-(BzlO₂C-CH₂-), N-(CF₃CO)-DCha-Pro-OtBu as an oil, 390 mg (86%).

15

20

¹H-Nmr(COCl₂) - complex due to presence of 4 rotamers - eg. tBu group at δ 1.4-1.5 was split four times in the ratio 1:0.25:0.8:0.4. δ 0.9(m), 1.1(m), 1.65(m), 1.95(m), 2.2(m) [17H]; 1.4-1.5 [4xs, 9H]; 3.1 (m), 3.5(m), 3.7(m) [2H]; 4.3-4.6 [m, 3H]; 5.05-5.4 (m, 3H); 7.35 [s, 5H].

25

(iv) The above product (335 mg) was treated with CH₂CL₂-TFA (1:1, 8 ml) for 2.5 h at room temperature. Evaporation followed by three evaporations from toluene gave the free acid, 100%.

30

(v) The previous acid was converted to its -ONSu ester (100%) using HONSu as described previously for Boc-

35

DCha-OH.

The intermediate may be coupled to $\text{H-Arg(Z)}_2\text{-CH}_2\text{-Y-R}^4$ using the general methods already outlined.

- 5 Deprotection procedure a provides the peptide protected with $\text{N-CF}_3\text{-CO-}$. The $\text{N-CF}_3\text{-CO}$ is removed by deprotection procedure d.

Deprotection procedures:

10

(a) The protected peptide in $\text{MeOH} / \text{H}_2\text{O}$ (3:1) containing 1M HCl (2 equivalents) was hydrogenated over 5% Pd/C at STP for 40 min. Filtration (0.2 μm) and evaporation was followed by lyophilization from water to give the peptides as fluffy white solids. Purification, if required, was carried out by MPLC (see general procedures).

15

(b) The protected peptide was first treated with 20 $\text{TFA/CH}_2\text{Cl}_2$ (1:1) for 1 hour and evaporated, then hydrogenated as above under (a).

(c) The COCOPh group was first hydrolysed as in (E)(ii) then hydrogenated over $\text{H}_2\text{-Pd/C}$ as in (a).

25

(d) Removal of $\text{N-CF}_3\text{-CO}$ (N-trifluoroacetyl):

The N-trifluoroacetyl peptide was dissolved in $\text{MeCN-H}_2\text{O-0.880 ammonia}$ (1:1:1) and kept at room temperature for 24 h. Evaporation followed by purification if necessary provided the peptide.

30

Examples

35 The following examples illustrates the principles of

the invention in more detail.

5 Examples of compounds of the invention are listed in Table 1, Table 2 indicates the procedures used in their preparation and described in the section titled "Preparation procedures", and Table 3 presents characterising data for the compounds listed.

Examples 1-37

Table 1

Example

Formula

No.

1	H-DCha-Pro-D, LArg-CH ₂ -OH
2	H-DCha-Pro-D, LArg-CH ₂ -O-Me
3	H-DCha-Pro-Arg-CH ₂ -O-CH ₂ -CF ₃
4	H-DCha-Pro-Arg-CH ₂ -O-CH(CF ₃) ₂
5	H-DCha-Pro-Arg-CH ₂ -O-C [*] H(Ph)-CF ₃
6	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-CH ₂ -CF ₃
7	Et-OOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-CH ₂ -CF ₃
8	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-CH ₂ -CF ₂ -CF ₂ -CF ₃
9	HOOC-CH ₂ -DCha-Pro-Arg-CH ₂ -O-Ph
10	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-Ph(4-OMe)
11	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-Ph(4-tBu)
12	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-Ph(4-Me)
13	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-Ph(4-F)
14	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-Ph(3-F)
15	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-Ph(2-F)
16	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-Ph(3-CF ₃)
17	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-Ph(4-CF ₃)
18	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-Ph(2-CF ₃)
19	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-C ₆ F ₅
20	HOOC-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-Et
21	HOOC-CH ₂ -DCha-Pro-Arg-CH ₂ -O-nPr
22	HOOC-CH ₂ -DCha-Pro-Arg-CH ₂ -O-nBu
23	HOOC-CH ₂ -DCha-Pro-Arg-CH ₂ -O-iBu
24	HOOC-CH ₂ -DCha-Aze-D, LArg-CH ₂ -O-CH ₂ -CF ₃
25	HOOC-CH ₂ -DCha-Pic-D, LArg-CH ₂ -O-CH ₂ -CF ₃
26	HOOC-CH ₂ -DCha-Pic-Arg-CH ₂ -O-nBu
27	Me-DCha-Pro-D, LArg-CH ₂ -O-CH ₂ -CF ₃
28	Me-SO ₂ -DCha-Pro-D, LArg-CH ₂ -O-CH ₂ -CF ₃
29	Ch-CH ₂ -DCha-Pro-D, LArg-CH ₂ -O-CH ₂ -CF ₃
30	(HOOC-CH ₂) ₂ -DCha-Pro-D, LArg-CH ₂ -O-CH ₂ -CF ₃

Table 1 (continued)

Example No.	Formula
31	$(\text{HOOC}-\text{CH}_2)_2-\text{DCha}-\text{Pro}-\text{Arg}-\text{CH}_2-\text{O}-i\text{Bu}$
32	$\text{HOOC}-\text{CH}_2-\text{CH}_2-\text{DCha}-\text{Pro}-\text{D}, \text{LArg}-\text{CH}_2-\text{O}-n\text{Bu}$
33	$\text{HOOC}-\text{CH}_2-\text{CH}_2-\text{DCha}-\text{Pro}-\text{Arg}-\text{CH}_2-\text{O}-\text{CH}_2-\text{CF}_3$
34	$\text{H}-(3-\text{trans}-\text{Ph})-\text{D}, \text{LPro}-\text{D}, \text{LArg}-\text{CH}_2-\text{O}-\text{CH}_2-\text{CF}_3$
35	$\text{H}-(3-\text{trans}-\text{Ch})-\text{D}, \text{LPro}-\text{D}, \text{LArg}-\text{CH}_2-\text{O}-\text{CH}_2-\text{CF}_3$
36	$\text{HOOC}-\text{CH}_2-\text{DCha}-\text{Pro}-\text{Arg}-\text{CH}_2-\text{S}-n\text{Bu}$
37	$\text{HOOC}-\text{CH}_2-\text{DCha}-\text{Pro}-\text{D}, \text{LArg}-\text{CH}_2-\text{SO}_2-n\text{Bu}$

* absolute configuration R or S

Table 2

Example No.	Preparation procedure	Deprotection procedure
----------------	--------------------------	---------------------------

1	D	c
2	E	b
3	A or C	b
4	A or C	b
5	A or C	b
6	A	a
7	A	a
8	F	a
9	A or D	a
10	F	a
11	D	a
12	D	a
13	D	a
14	D	a
15	D	a
16	D	a
17	D	a
18	D	a
19	D	a
20	E	a
21	E	a
22	E	a
23	E	a
24	A	a
25	A	a
26	E	a
27	A and F	a
28	A and G	a
29	A and H	a
30	A	a

Table 2 (continued)

Example No.	Preparation procedure	Deprotection procedure
----------------	--------------------------	---------------------------

31	E	a
32	E and B	b
33	A and B	b
34	I and A	b
35	I and A	b
36	D	a
37	D	a

Table 3

Example	Mol. Wt retention**	FAB MS	AAA: Peptide	HPLC
No.		(M + 1)	Content (%) *	time
	(min)/system			
1	438.57	439	56/Pro	10.3 /E
2	452.60	453	65/Pro	9.9 /E
3	520.6	521	59/Pro	8.6 /A
4	588.6	589	60/Pro	10.7 /A
5	596.7	597	61/Pro	12.2 /A
6	578.64	579	72/Pro	14.8 /C
7	606.69	607.7	65/Pro	22.0 /B
8	678.65	679.8	76/Pro	18.2 /G
9	572.71	573.3	73/Pro	19.9 /B
10	602.74	603.8	76/Pro	13.4 /G
11	628.82	629.5	77/Pro	22.0 /G
12	586.74	587.2	75/Pro	16.0 /G
13	590.70	591.4	76/Pro	15.2 /G
14	590.70	591.4	63/Pro	15.0 /G
15	590.70	591.4	54/Pro	14.0 /G
16	640.71	641.5	68/Pro	19.0 /G
17	640.71	641.6	70/Pro	20.0 /G
18	640.71	641.4	65/Pro	18.4 /G
19	662.66	663	49/Pro	21.0 /G
20	524.67	525.4	79/Pro	15.5 /B
21	538.69	539	67/Pro	9.2 /F
22	552.72	553	69/Pro	19.3 /B
23	552.72	553.4	56/Pro	9.2 /F
24	564.61	565	67/Aze	13.6 /D
25	592.66	593	90/Pic	8.4 /D
26	566.75	567.4	86/Pic	17.0 /G
27	534.63	535.6	70/Pro	18.8 /B
28	598.69	599	71/Pro	11.2 /D

Table 3 (continued)

Example No.	Mol. Wt retention** (min)/system	FAB MS (M + 1)	AAA: Peptide Content (%)*	HPLC time
29	616.77	617	64/Pro	14.5 /C
30	636.67	637.6	70/Pro	12.0 /A
31	610.76	611.2	67/Pro	10.0 /F
32	566.75	567.5	65/Pro	19.7 /B
33	592.66	593	46/Pro	10.6 /F
34	540.59	541	56/Pro	14.3 /C
35	546.64	547	49/Pro	15.9 /C
36	568.78	569.4	45/Pro	17.4 /G
37	600.78	601.3	62/Pro	14.6 /G

*Based on amino acid as indicated

**See General experimental procedures. Times are given for L-Arg epimers. D-epimers (minor) usually run about 0.5 min earlier.

System A: 20% increased to 80% of 1% TFA-MeCN into 1% TFA-H₂O over 25 min. (20-80%, 25 min)

System B: 10-60%, 30 min

System C: 10-90%, 30 min

System D: 30-100%, 30 min

System E: 10-90%, 20 min

System F: 20-100%, 20 min

System G: 20-70%, 30 min

Example 38

Solution for continuous intravenous administration

A solution is prepared from the following ingredients:

5	Thrombin inhibitor	50 mg
	Sodium chloride for injection	4.5 g
	Water for injection up to 500 ml	

10 The active constituent and the sodium chloride are dissolved in the water whereafter the solution is filtered and then sterilised by autoclaving or by filtration through a sterile 0.2 μ m filter and aseptically filled into sterile infusion bottles.

15 Example 39

Solution for injection.

A solution is prepared from the following ingredients:

	Thrombin inhibitor	5 g
20	Sodium chloride for injection	9 g
	Water for inj. up to 1000 ml	

25 The active constituent and the sodium chloride are dissolved in the water whereafter the solution is filtered and then sterilised by autoclaving or by filtration through a sterile 0.2 μ m filter and aseptically filled into sterile ampoules (5 ml).

Example 40

30 Solution for nasal administration

A solution is prepared from the following ingredients:

	Thrombin inhibitor	10 g
	Glycerol	200 g
35	Methyl p-hydroxybenzoate	1 g

Propyl p-hydroxybenzoate 0.2 g
Water for inj. up to 1000 ml

- 5 The active constituent and the preservatives were dissolved in glycerol and the main part of the water. The volume is then adjusted to 1000 ml and the solution is filled into sterile polyethylene containers.

Example 41

- 10 Tablets for oral administration
1000 tablets are prepared from the following ingredients:

	Thrombin inhibitor	100 g
15	Lactose	200 g
	Polyvinyl pyrrolidone	30 g
	Microcrystalline cellulose	30 g
	Magnesium stearate	6 g

- 20 The active constituent and lactose are mixed with an aqueous solution of polyvinyl pyrrolidone. The mixture is dried and milled to form granules. The microcrystalline cellulose and then the magnesium stearate are then admixed. The mixture is then
25 compressed in a tablet machine giving 1000 tablets, each containing 100 mg of active constituent.

Example 42

Gelatine capsules for oral administration

Gelatine capsules are filled with a mixture of the following ingredients:

5

Thrombin inhibitor	50 mg
Magnesium stearate	3 mg
Lactose	100 mg

10

Biology

Determination of thrombin clotting time and IC_{50}^{TT} :

15 Human thrombin (T 6769, Sigma Chem Co) in buffer solution, pH 7.4, 100 μ l, and inhibitor solution, 100 μ l, are incubated for one min. Pooled normal citrated human plasma, 100 μ l, is then added and the clotting time measured in an automatic device (KC 10, Amelung).

20 The clotting time in seconds is plotted against the inhibitor concentration, and the IC_{50}^{TT} is determined by interpolation.

25 IC_{50}^{TT} is the concentration of inhibitor that doubles the thrombin clotting time for human plasma. pIC_{50}^{TT} is the $-\log_{10}$ of IC_{50}^{TT} in mol/l. The results are presented in Table 4.

Table 4Example pIC₅₀^{TT}

No.

5	1	7.71
	2	7.81
	3	7.92
	4	7.38
10	5	7.77
	6	8.04
	7	7.70
	8	7.64
	9	8.45
15	10	7.90
	11	7.86
	12	8.25
	13	8.22
	14	8.15
20	15	8.12
	16	7.77
	17	8.68
	18	7.30
	19	8.27
25	20	8.17
	21	8.14
	22	8.69
	23	7.64
	24	8.01
30	25	8.00
	26	7.89
	27	7.52
	28	6.85
	29	6.47
35	30	7.38

Table 4 (continued)Example pIC₅₀TT

No.

5	31	6.88
	32	7.63
	33	7.78
	34	7.03
10	35	7.25
	36	7.57
	37	7.72

ABBREVIATIONS

	4-DMAP =	4-dimethylamino pyridine
	AAA =	amino acid analysis
5	Arg =	L-arginine
	Arg(Z ₂) =	ÜN, N-dibenzylloxycarbonyl-L-arginine
	Aze =	L-azetidine-2-carboxylic acid
	Boc =	tertiary butoxy carbonyl
10	Bu =	butyl
	Bzl =	benzyl
	Ch =	cyclohexyl
	Cha =	L-β-cyclohexylalanine
	DMF =	dimethyl formamide
15	Et =	ethyl
	EtOAc =	ethyl acetate
	FAB =	fast atom bombardment
	FI to FXIII =	coagulation factors I to XIII
	FII _a to FXIII _a =	activated form of coagulation
20	factors	II to XIII
	Gly =	glycine
	HMW-K =	high molecular weight kininogen
	HOAc =	acetic acid
	HONSu =	N-hydroxysuccinimide
25	HPLC =	high performance liquid chromatography
	iBC =	isobutyl chloroformate
	Kall =	kallikrein
	Me =	methyl
30	MPLC =	medium pressure liquid chromatography
	NMM =	N-methyl morpholine
	Nph =	naphthyl
	Ph =	phenyl
35	Pic =	L-pipecolinic acid

	PL =	phospholipids
	Pr =	propyl
	Prekall =	prekallikrein
	Pro =	L-proline
5	STP =	standard temperature and pressure
	Tce =	2,2,2-trichloroethyl
	TFA =	trifluoroacetic acid
	THF =	tetrahydrofuran
	Val =	L-valine
10	WSCDI =	water soluble carbodiimide
	Z =	benzyloxy carbonyl

Prefixes n, i and t have their usual meanings: normal, iso and tertiary.

SEQUENCE LISTING

NUMBER OF SEQUENCES: 1

5 (1) INFORMATION FOR SEQ ID NO:1
 (i) SEQUENCE CHARACTERISTICS:
 (A) LENGTH: 20 amino acids
 (B) TYPE: amino acid
 (D) TOPOLOGY: linear

10
 (ii) MOLECULE TYPE: peptide

 (iii) HYPOTHETICAL: NO

15 (vi) ORIGINAL SOURCE:
 (A) ORGANISM: Homo sapiens

 (ix) FEATURE:
 (A) NAME/KEY: Peptide
20 (B) LOCATION: 1..20
 (D) OTHER INFORMATION: /note= "Peptide
 sequence containing thrombin cleavage
 site in the human fibrinogen A-alpha
 chain."

25
 (ix) FEATURE:
 (A) NAME/KEY: Cleavage-site
 (B) LOCATION: 16..17

30 (xi) SEQUENCE DESCRIPTION: SEQ ID NO:1:

Ala Asp Ser Gly Glu Gly Asp Phe Leu Ala Glu Gly Gly Gly
1 5 10
Val Arg Gly Pro Arg Val
35 15 20

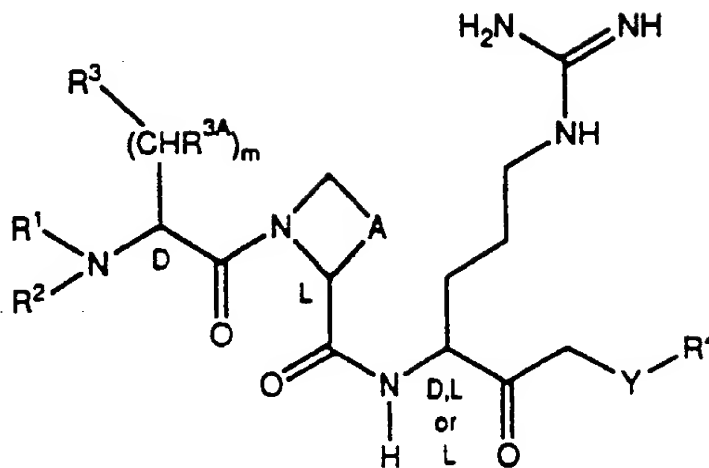
CLAIMS

1. A compound of the general formula

5

10

15



1

20

wherein:

A represents $-\text{CH}_2-$, $-\text{CH}=\text{CH}-$, $-\text{CH}_2-\text{CH}_2-$ or $-\text{CH}_2-\text{CH}_2-\text{CH}_2-$;

25

R^1 and R^2 are the same or different and each represents H or X-B-, where B is a straight or branched alkylene group having 1-3 carbon atoms and X is H, methyl, ethyl, a cycloalkyl group having 3-6 carbon atoms or $\text{R}'\text{CO}-$, where R' is OH, a straight or branched alkoxy group having 1-4 carbon atoms, NH_2 or NHR'' , where R'' is a straight or branched alkyl group having 1-4 carbon atoms, or X is a carboxylic acid mimic, known per se, selected from $-\text{PO}(\text{OR}''')_2$, $-\text{SO}_3\text{H}$ and 5-(1H)-tetrazolyl, and R''' is H, methyl or ethyl, or B is $-\text{SO}_2-$ and X is methyl or ethyl;

35

m is 0, 1 or 2, R^3 represents a cyclohexyl group and R^{3A} represents H; or

5 m is 1 and R^3 represents a cyclohexyl or phenyl group and R^{3A} forms an ethylene bridge together with R^1 ;

Y represents O or $S(O)_p$, where p is 0, 1 or 2;

10 R^4 represents H; a straight or branched alkyl or a cycloalkyl having 1 to 6 carbon atoms unsubstituted or substituted with one or more fluoro atoms and/or substituted with a phenyl group; a substituted or unsubstituted aromatic ring selected from phenyl, 4-methoxy-phenyl, 4-tertiary-butyl-phenyl, 15 4-methyl-phenyl, 2-, 3- or 4-trifluoro-methyl-phenyl, phenyl substituted with 1-5 fluoro atoms; or -CH(CF₃)-phenyl, either as such or in the form of a physiologically acceptable salt and including stereoisomers.

20

2. A compound according to claim 1 wherein

A represents -CH₂-CH₂- or -CH₂-CH₂-CH₂-;

25 R^1 is H and R^2 represents HOCO(CH₂)_n- or CH₃CH₂OCO(CH₂)_n-, and n is 1 or 2;

Y is O

30 m is 1, R^3 represents a cyclohexyl group and R^{3A} represents H.

3. A compound according to claim 1 selected from
- H-DCha-Pro-Arg-CH₂-OH,
H-DCha-Pro-Arg-CH₂-O-Me,
H-DCha-Pro-Arg-CH₂-O-CH₂-CF₃,
5 H-DCha-Pro-Arg-CH₂-O-CH(CF₃)₂,
H-DCha-Pro-Arg-CH₂-O-(R or S)CH(Ph)-CF₃,
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-CH₂-CF₃,
Et-OOC-CH₂-DCha-Pro-Arg-CH₂-O-CH₂-CF₃,
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-CH₂-CF₂-CF₂-CF₃,
10 HOOC-CH₂-DCha-Pro-Arg-CH₂-O-Ph,
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-Ph(4-OMe),
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-Ph(4-tBu),
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-Ph(4-Me),
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-Ph(4-F),
15 HOOC-CH₂-DCha-Pro-Arg-CH₂-O-Ph(3-F),
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-Ph(2-F),
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-Ph(3-CF₃),
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-Ph(4-CF₃),
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-Ph(2-CF₃),
20 HOOC-CH₂-DCha-Pro-Arg-CH₂-O-C₆F₅,
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-Et,
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-nPr,
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-nBu,
HOOC-CH₂-DCha-Pro-Arg-CH₂-O-iBu,
25 HOOC-CH₂-DCha-Aze-Arg-CH₂-O-CH₂-CF₃,
HOOC-CH₂-DCha-Pic-Arg-CH₂-O-CH₂-CF₃,
HOOC-CH₂-DCha-Pic-Arg-CH₂-O-nBu,
Me-DCha-Pro-Arg-CH₂-O-CH₂-CF₃,
Me-SO₂-DCha-Pro-Arg-CH₂-O-CH₂-CF₃,
30 Ch-CH₂-DCha-Pro-Arg-CH₂-O-CH₂-CF₃,
(HOOC-CH₂)₂-DCha-Pro-Arg-CH₂-O-CH₂-CF₃,,
(HOOC-CH₂)₂-DCha-Pro-Arg-CH₂-O-iBu,
HOOC-CH₂-CH₂-DCha-Pro-Arg-CH₂-O-nBu,
HOOC-CH₂-CH₂-DCha-Pro-Arg-CH₂-O-CH₂-CF₃,
35 H-(3-trans-Ph)-Pro-Arg-CH₂-O-CH₂-CF₃,

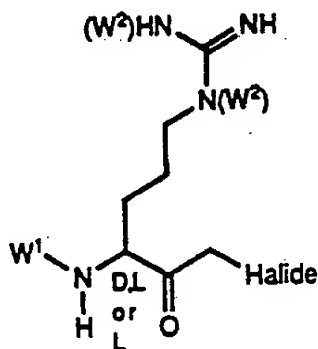
H-(3-trans-Ch)-Pro-Arg-CH₂-O-CH₂-CF₃,
 HOOC-CH₂-DCha-Pro-Arg-CH₂-S-nBu and
 HOOC-CH₂-DCha-Pro-Arg-CH₂-SO₂-nBu,
 either as such or in the form of a physiologically
 acceptable salt and including stereoisomers.

4. A compound according to claim 1 selected from
 HOOC-CH₂-DCha-Pro-Arg-CH₂-O-CH₂-CF₃,
 HOOC-CH₂-DCha-Pic-Arg-CH₂-O-CH₂-CF₃,
 HOOC-CH₂-DCha-Pic-Arg-CH₂-O-nBu,
 HOOC-CH₂-CH₂-DCha-Pro-Arg-CH₂-O-nBu,
 HOOC-CH₂-CH₂-DCha-Pro-Arg-CH₂-O-CH₂-CF₃ and
 HOOC-CH₂-DCha-Pro-Arg-CH₂-O-nBu,
 either as such or in the form of a physiologically
 acceptable salt and including stereoisomers.

5. A compound according to any of claims 1-4 for use in
 therapy.

6. A process for preparing a compound according to any
 of claims 1-4, which process comprises

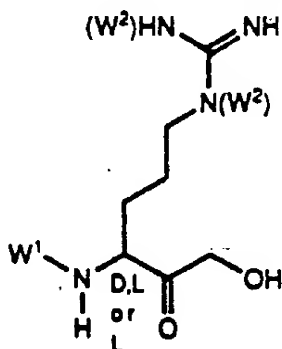
(method I) displacement by R⁴Y⁻ (Y=O,S) of the halogen
 of a halomethylketone of the formula



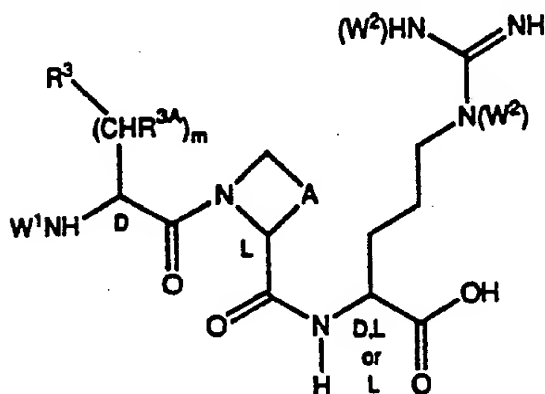
wherein W¹ is an amino terminal protecting group and W²
 is a protecting group, reduction of the ketone to

alcohol, removal of the amino terminal protecting group, standard peptide coupling, followed by oxidation of the alcohol, giving the protected tripeptide ketone, removal of the amino terminal protecting group, followed by N-alkylation, and deprotection, or replacing a protected dipeptide in the coupling reaction referred to above with an amino-terminal-N-alkylated-N-trifluoroacetyl-protected dipeptide, followed by oxidation and deprotection, or

(method II) alkylation, with an R^4 -halide, of an α -ketol of the formula



wherein W^1 and W^2 are as defined above, and then further reacting as in method I, or (method III) reacting a compound of the formula



wherein W^1 and W^2 are as defined above, with $(T-CH_2CO)_2O$ wherein T is halogen, R^4O or R^4S and 4-DMAP, and then further reacting as in method I, and if

desired forming a physiologically acceptable salt, and in those cases where the reaction results in a mixture of stereoisomers, these are optionally separated by standard chromatographic or re-crystallisation techniques, and if desired a single stereoisomer is isolated.

7. A pharmaceutical preparation comprising an effective amount of any of the compounds outlined in claims 1-4, and furthermore comprising one or more pharmaceutical carriers.

8. Use of compound according to any of claims 1-4 as an active ingredient for manufacture of a pharmaceutical preparation for inhibition of thrombin in a human or animal organism.

9. Use of compound according to any of claims 1-4 as an anticoagulant agent.

10. A method for obtaining inhibition of thrombin in a human or animal organism in need of such inhibition, comprising administering to said organism an inhibitory effective amount of a compound claimed in any of claims 1-4.

11. A method of treatment or prophylaxis of thrombosis and hypercoagulability in blood and tissues in a human or animal organism, comprising administering to a host in need of such treatment or prophylaxis an effective amount of a compound claimed in any of claims 1-4.

12. A compound, a process, a pharmaceutical preparation, a use and a method as claimed in any of claims 1-11 and substantially as described.

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 92/00584

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: C 07 K 5/08, A 61 K 37/64														
II. FIELDS SEARCHED <div style="text-align: center; border: 1px solid black; padding: 2px;">Minimum Documentation Searched⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 20%; border: 1px solid black; padding: 2px;">Classification System</th> <th style="border: 1px solid black; padding: 2px;">Classification Symbols</th> </tr> <tr> <td style="border: 1px solid black; padding: 5px; vertical-align: top;">IPC5</td> <td style="border: 1px solid black; padding: 5px; vertical-align: top;">A 61 K; C 07 K</td> </tr> </table> <div style="text-align: center; border: 1px solid black; padding: 2px;">Documentation Searched other than Minimum Documentation to the extent that such Documents are included in Fields Searched⁸</div> <p style="padding: 5px;">SE,DK,FI,NO classes as above</p>			Classification System	Classification Symbols	IPC5	A 61 K; C 07 K								
Classification System	Classification Symbols													
IPC5	A 61 K; C 07 K													
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; padding: 2px;">Category¹⁰</th> <th style="width: 60%; padding: 2px;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="width: 30%; padding: 2px;">Relevant to Claim No.¹³</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">EP, A2, 0192135 (BEHRINGWERKE AKTIENGESELLSCHAFT) 27 August 1986, see the whole document --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-8, 12</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">US, A, 4318904 (E.N. SHAW ET AL.) 9 March 1982, see the whole document --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-8, 12</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">P,A</td> <td style="padding: 5px;">EP, A2, 0479489 (ELI LILLY AND COMPANY) 8 April 1992, see the whole document -----</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-8, 12</td> </tr> </tbody> </table>			Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	A	EP, A2, 0192135 (BEHRINGWERKE AKTIENGESELLSCHAFT) 27 August 1986, see the whole document --	1-8, 12	A	US, A, 4318904 (E.N. SHAW ET AL.) 9 March 1982, see the whole document --	1-8, 12	P,A	EP, A2, 0479489 (ELI LILLY AND COMPANY) 8 April 1992, see the whole document -----	1-8, 12
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P,A	EP, A2, 0479489 (ELI LILLY AND COMPANY) 8 April 1992, see the whole document -----	1-8, 12												
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>* Special categories of cited documents:¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p> </div> </div>														
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of the Actual Completion of the International Search 1st December 1992 </td> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of Mailing of this International Search Report 03 -12- 1992 </td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;"> International Searching Authority SWEDISH PATENT OFFICE </td> <td style="border: 1px solid black; padding: 5px;"> Signature of Authorized Officer Elisabeth Carlborg </td> </tr> </table>			Date of the Actual Completion of the International Search 1st December 1992	Date of Mailing of this International Search Report 03 -12- 1992	International Searching Authority SWEDISH PATENT OFFICE	Signature of Authorized Officer Elisabeth Carlborg								
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FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☒ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE¹

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☒ Claim numbers 9-11, because they relate to subject matter not required to be searched by this Authority, namely:

See PCT Rule 39.1(iv): Methods for treatment of the human or animal body by surgery or therapy, as well as diagnostic methods.

2. ☐ Claim numbers....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers....., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 8.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING²

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims. It is covered by claim numbers:
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 92/00584**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 30/10/92. The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A2- 0192135	86-08-27	AU-B- 589159	89-10-05
		AU-D- 5372786	86-08-21
		CA-A- 1269200	90-05-15
		DE-A- 3505555	86-09-11
		JP-A- 61189298	86-08-22
		US-A- 4713369	87-12-15
US-A- 4318904	82-03-09	NONE	
EP-A2- 0479489	92-04-08	AU-D- 8478091	92-04-02
		CN-A- 1060472	92-04-22